

**EFFECTS OF DWELLING CONDITIONS ON CARDIOVASCULAR PARAMETERS
IN SPONTANEOUSLY HYPERTENSIVE RATS (SHR)**

Kohei Kawakami^{*}, Shunsuke Shimosaki^{*§}, Takao Nishimura[§], Kiyoshi Takesue[§], Masato

Nomura[‡], Yuta Kobayashi[#] and Toru Nabika[¶]

**Department of Experimental Animals, Centre for Integrated Research in Science, § Research Project Promotion Institute, #Department of Fundamental Nursing, ¶ Department of Functional Pathology, Faculty of Medicine, Shimane University, Izumo, §Globe, Inc., Tokyo, ‡Department of Biotechnology and Chemistry Faculty of Engineering, Kinki University, Hiroshima, Japan.*

Short title: Effects of the living condition on SHR

Address correspondence to: Kohei Kawakami, PhD,

Department of Experimental Animals,

Centre for Integrated Research in Science, Shimane University,

Izumo 693-8501, Japan.

Email: kkawaka@med.shimane-u.ac.jp

Phone: +81-853-20-2363

Fax: +81-853-20-2360

SUMMARY

1. The living condition is an important environmental factor for laboratory animals.

We studied the effects of different living conditions on the cardiovascular parameters in spontaneously hypertensive rats (SHR).

2. In both light and dark phase, heart rate of rats kept in a wire-mesh cage was significantly greater than those of rats under the other living conditions (with wood-shaving bedding material in a plastic cage, with cloth bedding material in a plastic cage, with cloth bedding material in a wire-mesh cage, $p < 0.01$ by the paired t-test).

3. Systolic blood pressure and diastolic blood pressure of rats in a wire-mesh cage in light phase was significantly higher than those of rats under the other living conditions (with wood-shaving bedding materials in a plastic cage, with cloth bedding materials in a plastic cage, $p < 0.01$ by the paired t-test).

4. Based on these results, we concluded that the living condition imposed substantial influence on the cardiovascular parameters in SHR.

Key words: environmental enrichment, living condition, SHR

INTRODUCTION

Residential materials, such as a cage and a bedding material, are one of the important environmental factors for rodents as the animals directly touch and sometime bite them.¹ It is therefore possible that the difference in the residential conditions has influences not only on the animal's health and welfare, but also on the results of physiological experiments. Until now, wood chips, paper bedding materials made from wood pulp and recycled used paper are conventionally used as the bedding materials of laboratory rodents.^{2, 3} However, the increasing interest in protecting the environment and natural resources requires alternatives. In this context, a cloth bedding materials (AgrebeTM) was recently developed, which could chemically adsorb the ammonia and was reusable after washing.⁴ This may have several advantages in terms of the animal welfare as well as the preservation of natural resources used as the residential material. In the present study, we therefore investigated the effects of different residential materials on blood pressure and heart rate in spontaneously hypertensive rat (SHR).

METHODS

Six male SHR/Izm (8 weeks old) were used in this study. They were kept in an animal room under a standard condition (temperature: $23\pm 2^{\circ}\text{C}$, lighting: 12hr/day). This study was approved by the ethical committee for animal research of Shimane University. The telemetric

transmitter for heart rate (HR) and blood pressure (TA11PA-C40, Data Sciences, USA) were implanted in the abdominal cavity under anesthesia with pentobarbital sodium (50mg/kg.ip.) as described previously in detail.⁵ The signals of HR, systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded continuously at 5 min intervals; all data during the light phase (7:00-19:00) and the dark phase (19:00-7:00) were averaged. The mean values of 7 days of the experimental period were shown in the figure. Four conditions, a plastic cage with wood-shaving bedding material (PWS), a wire-mesh cage with no bedding material (WMC), a plastic cage with AgrebeTM (PAG) and a wire-mesh cage with AgrebeTM (WAG), were evaluated in the study. A rat was housed individually in one condition for 7 days and was transferred into another condition. Data are expressed as mean±standard error of the mean (SEM). The paired t-test was performed for statistical analysis. A values of P<0.05 was taken as statistically significant.

RESULTS

As shown in Figure 1, HR of rats in WMC was significantly greater than that in other groups both in the light and dark phase. Both SBP and DBP of rats in WMC were significantly higher than that in PWS and in PAG in the light phase. Both SBP and DBP of rats in WAG also showed smaller tendency compared with those in WMC. Although significant difference

between WMC and PAG was lost in the dark phase, there were the same tendencies as those in the light phase. All HR, SBP and DBP changes showed an obvious nocturnal pattern.

DISCUSSION

In this study, we investigated effects of different dwelling conditions on the cardiovascular parameters in SHR. The cage enrichments reduced HR and SBP in rats, suggesting reduced levels of the stress. By nature, rats are a nocturnal animal that prefer to hide and sleep in a dark place during the daytime. The two bedding materials used in the present study probably provided rats with such a condition.² In addition, these materials might give a better condition to keep the body temperature.¹ Further, rats bred in a wire-mesh cage were restricted from scooping out a hole.⁶ Thus, rats under WMC in the present study might have more emotional or psychosocial stress. In this context, it is the most important for us to select residential materials to meet the essential behavioral needs of animals when considering the improvement of the animal welfare.

In conclusion, the present study indicated that the living condition imposed substantial influence on the cardiovascular parameters in SHR.

ACKNOWLEDGEMENTS

This study was supported, in part, by a Grant-in-Aid for Scientific Research from the Japanese Ministry of Education, Science, Sports, Culture and Technology (No.17916003).

REFERENCES

1. Kawakami K, Takeuchi T, Ago A, Gonda T. Influence of environmental factors on the development of stroke in stroke-prone spontaneously hypertensive rats (SHRSP): effects of residential condition and population density. *Shimane J. Med. Sci.* 2002; **20**: 13-8.
2. Van de Weerd HA, Van den Brock FAR, Baumaus V. Preferences for different types of flooring in two rat strains. *Applied Anim. Behav. Sci.* 1996; **46**: 251-61.
3. Blom HJM, Van Tintelen G, Van Vorstenbosch CJAHV, Baumans V, Beynen AC. Preferences of mice and rats for types of bedding material. *Lab. Anim.* 1996; **30**: 234-44.
4. Kawakami K, Komura K, Nishimura T, Ichino M, Ago A, Takasue K, Nabika T, Harada T. Evaluation of a new bedding material (Agrebe™) for mice. *Kyusyu J. Exp. Anim.* 2005; **21**: 13-9.
5. Brockway BP, Mills PA, Azar SH. A new method for continuous chronic measurement and recording of blood pressure, heart rate and activity in the rat via radio telemetry. *Clin. Exp. Hypertens. Part A Theory Pract.* 1991; **A13**: 885-95.
6. Yamori Y, Eguch T, Tsuchikura S, Ikeda K. Analysis of environmental factors on the

development of stroke in Stroke-prone SHR: Influence of types of cages with or without bedding. *Jpn Heart J.* 1989; 568.

Figure legends

Fig.1 Effects of the different living conditions on cardiovascular parameters in spontaneously hypertensive rats (SHR). Heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were shown in both the light and dark phase separately. PWS, a plastic cage with wood-shaving bedding material; WMC, a wire-mesh cage without bedding materials; PAG, a plastic cage with AgrebeTM; WAG, a wire-mesh cage with AgrebeTM. Data are the mean±SEM. * p<0.05, ** p<0.01, *** p<0.001 by the paired t-test.

Fig.1

